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Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

November 11, 1913.

EXPERIMENTS IN BULB GROWING AT THE UNITED STATES BULB GARDEN AT BELLINGHAM.[1]

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INTRODUCTION.

The United States to-day is one of the largest consumers of what are known as "Dutch bulbs." The value of the annual imports of these extremely popular spring-flowering bulbs for planting out of doors and forcing under glass exceeds $1,000,000. The major part of these should, and it is believed can, be grown at home.

[1] As a result of extensive tests of Holland bulbs on the trial grounds of the Department of Agriculture on the Potomac Flats, which were carried on for several years under the direction of Mr. A. J. Pieters, Botanist in Charge of the Office of Congressional Seed Distribution, Mr. L. C. Corbett, Horticulturist, Mr. George W. Oliver, Expert in Plant Propagation, and Mr. Henry E. Juenemann, Gardener, and after preliminary surveys by these gentlemen in 1906 and 1907 in the Puget Sound region and other sections of the United States, with a view to finding soil and climatic conditions similar to those of the bulb-growing sections of the Netherlands, a garden for the propagation of these bulbs was established near Bellingham, Wash., on a tract of 10 acres furnished by the Bellingham Chamber of Commerce. The preliminary details involved in securing the active cooperation of the local authorities and establishing the garden were arranged by Mr. Lisle Morrison, Assistant in Charge of the Office of Congressional Seed Distribution, and the first bulbs were planted in the autumn of 1908 by Mr. Juenemann, who has since resided at the garden and personally superintended the work of propagating, planting, cultivating, harvesting, and curing the bulbs. Since July, 1909, the administrative details connected with the management of the garden have been under the supervision of Mr. Leon M. Estabrook, Assistant in Charge of the Office of Congressional Seed Distribution, from which the funds for carrying on the work are supplied, while the cultural and practical work at the garden has been under the supervision of Mr. P. H. Dorsett, Plant Introducer in Charge of Plant-Introduction Field Stations, and Mr. Peter Bisset, Plant Introducer in Charge of Foreign-Plant Distribution, both of the office of Foreign Seed and Plant Introduction.

It is in response to the increasing demand for information regarding the growing of these bulbs in this country, especially at Bellingham, that this preliminary report showing progress and the present status of this work has been prepared, but the results here outlined should not induce anyone to take up "Dutch-bulb" growing in the United States without first thoroughly investigating the local conditions.—Wm. A. Taylor, *Chief of Bureau.*

Among the earlier experimenters in bulb growing on the Pacific coast with whom the Department of Agriculture cooperated is Mr. Carl Purdy, of Ukiah, Cal. As early as 1902 Mr. Purdy wrote:

Some years ago I went into the high mountains east of this place to grow lilies, and soon followed with all my bulbs, narcissus included. The bulbs that I produce are, I claim, superior to any that I import, and very hard, clean, and free from rot. It is certain that narcissus can be grown as cheaply here as in England and of better quality. I find no difficulty in growing good tulip bulbs with plenty of offsets, but I can as yet hardly produce as large ones as the best Dutch growers send out; still I regard it as a matter of fertilization to do so. The flowers are of a higher grade. I am practically barred at present from the eastern market by the high freight rate, as at $3 per hundred pounds the protection is more than neutralized.

Mr. John W. Macrae Smith, of Bellingham, Whatcom County, Wash., in November, 1902, sent to the Department of Agriculture samples of narcissus, tulip, and hyacinth bulbs that he had grown, and under date of December 8, 1902, replying to a request for a collection of bulbs for testing, wrote as follows:

I am very sorry to say that my bulbs are all planted and most of them coming through the ground. I am greatly disappointed at not being able to have a proper test made, as it postpones until another year a matter that I am very anxious to have settled, and that is the superiority of home-grown bulbs over any imported stock. Bulb growing so far has been very discouraging financially. It takes about three years to produce marketable bulbs, and a man of moderate means can not afford to put his time and money into a business where he has to wait so long for returns and then has to take chances as to whether the market is ready for him.

Mr. George Gibbs, of Clearbrook, Wash., more than fourscore years of age, is enthusiastic over the results of his experiments in bulb growing, as outlined in his early correspondence with the Department of Agriculture, and is firmly convinced that Dutch bulbs equal to, and possibly in some respects superior to, those grown in other countries can be grown in that region. Under date of April 19, 1903, he wrote that he wished "to see the industry started correctly and early put upon a paying basis, with the very best varieties money can buy." Mr. Gibbs has lived to see the Department of Agriculture take up the work, and he may yet realize his hopes as to the commercial production of bulbs in the Puget Sound region.

In 1907 Dr. B. T. Galloway, then Chief of the Bureau of Plant Industry, under whose direction this work has been carried on, sent experts into the Puget Sound region and other sections of the United States for the purpose of selecting the location which in their judgment was best adapted for bulb growing. Upon receipt of their report in 1908 Hon. James Wilson, the Secretary of Agriculture, authorized the establishment of a garden near the city of Bellingham, Wash.

The members of the Bellingham Chamber of Commerce, with whom this matter was taken up, realizing the great importance of this line of work and seeing in it the possibility of an American industry, entered heartily into its support. They secured 10 acres of suitable land, supplied the necessary improvements, and leased the whole to the Department of Agriculture for 10 years at a nominal rental of $1 per annum, this tract to be used to determine whether or not Holland bulbs could be successfully propagated and grown there.

LOCATION OF THE GARDEN.

The garden is conveniently located, about 2½ miles west of the city of Bellingham, Wash. (Fig. 1.) It embraces a narrow strip of

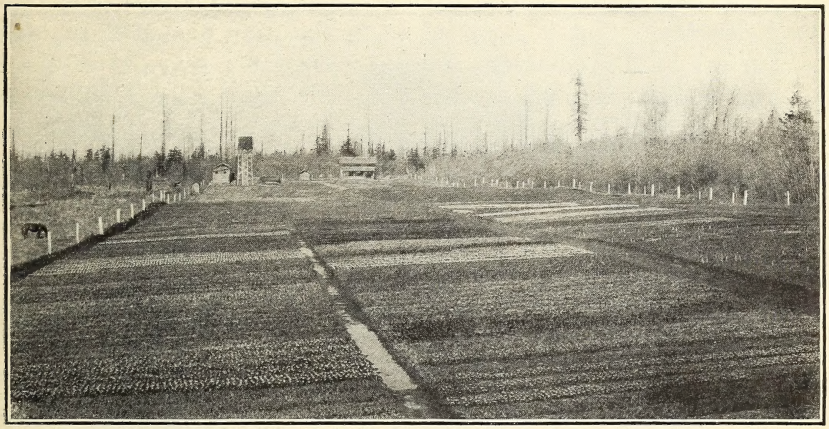

FIG. 1.—General view of the United States Bulb Garden at Bellingham, Wash. From a photograph taken at the bulb house, near the south end of the property, in April, 1911, immediately after a heavy rain.

land about 250 feet wide by 1,600 feet long, extending from the Marietta road on the north to Bellingham Bay on the south.

Bellingham is in latitude about 48° north, longitude about 122° west. The records of the Weather Bureau for the nine years 1898 to 1906, inclusive, show that the nine hottest days in that period had an average temperature of 85° F., while the nine coldest days averaged 12° above zero. The mean annual temperature for the same period was 50.2° F. The annual rainfall is from 30 to 40 inches, distributed pretty well throughout the year, but with the least precipitation during the months of June, July, and August. During these months the rainfall is normally ½, 1, and 2 inches, respectively.

SOIL OF THE GARDEN.

The soil of the Puget Sound region in which the United States Bulb Garden is located has been classified by the Bureau of Soils of

the United States Department of Agriculture as "Bellingham silt loam," and is thus described in a report dated January 30, 1909, entitled "Soil Survey of Bellingham Area, Washington":

The soil of the Bellingham silt loam, to an average depth of 12 inches, is a dark brown to drab colored heavy silt loam, carrying a large quantity of decomposed organic matter. When turned up with a plow and in a dry condition, the soil becomes lighter in color and has a light-brown or grayish appearance. The subsoil is a heavy drab-colored to slightly mottled silt loam, which becomes somewhat heavier and more compact as the depth increases, and at 30 to 36 inches usually has the characteristics of a silt clay. Small pockets of gravel or coarse sand are frequently encountered in the deeper subsoil.

The mechanical analysis of a sample of the Bellingham silt loam in comparison with a sample from the island of Guernsey, one from the Netherlands that is reported to be the type of soil best suited to hyacinth-bulb production, and one from the average type of soil in the Netherlands used for hyacinth-bulb production is shown in Table I.

TABLE I.—*Mechanical analyses of soils used for growing bulbs on the island of Guernsey, in the Netherlands, and at the United States Bulb Garden at Bellingham, Wash.*

Locality.	Fine gravel (2–1 mm.).	Coarse sand (1–0.5 mm.).	Medium sand (0.5–0.25 mm.).	Fine sand (0.25–0.1 mm.).	Very fine sand (0.1–0.05 mm.).	Silt (0.05–0.005 mm.).	Clay (0.005–0 mm.).
Island of Guernsey	5.6	7.8	4.8	12.1	15.8	38.3	15.5
Netherlands, best type of soil	.0	.4	19.5	78.5	.7	.6	.4
Netherlands, average type of soil	.3	.6	10.3	76.7	2.5	5.5	4.0
Bellingham silt loam	.3	1.3	.4	2.7	8.3	68.7	18.1

It will be noted that the Bellingham silt loam is low in medium and fine sand and high in silt and clay. Tests at the Bellingham bulb garden lead to the belief that the lighter type of soil—that is, the one containing the highest percentage of medium and fine sand and consequently low in silt and clay—is best suited to hyacinth-bulb growing.

The work thus far has included the propagation and growing of hyacinths, tulips, and narcissuses. At the time the garden was established 170,466 bulbs were planted. In 1912, in addition to over 1,000,000 bulbs planted, approximately 33,000 were put into the congressional distribution of the Department of Agriculture.

HYACINTHS.

In the eighteenth century hyacinths were among the most prized of cultivated florists' flowers, and enthusiasts of those days paid as much as £200 sterling ($973.30) for single bulbs of exceptional

merit.[1] They are to-day held in very high esteem both in America and abroad, but are not as highly prized as many other flowers, either for forcing or planting out of doors. Hyacinths are most successfully grown in a 3-year or a 4-year rotation in very light, well-drained, friable sandy-loam soil, well enriched by an application of 2 or 3 inches of well-rotted cow manure, which should be thoroughly incorporated with the soil prior to planting the bulbs.

PROPAGATION.

Hyacinths are propagated naturally either by slabs or by seed; artificially by bulblets secured either by means of scooping or scoring mature or so-called mother bulbs.

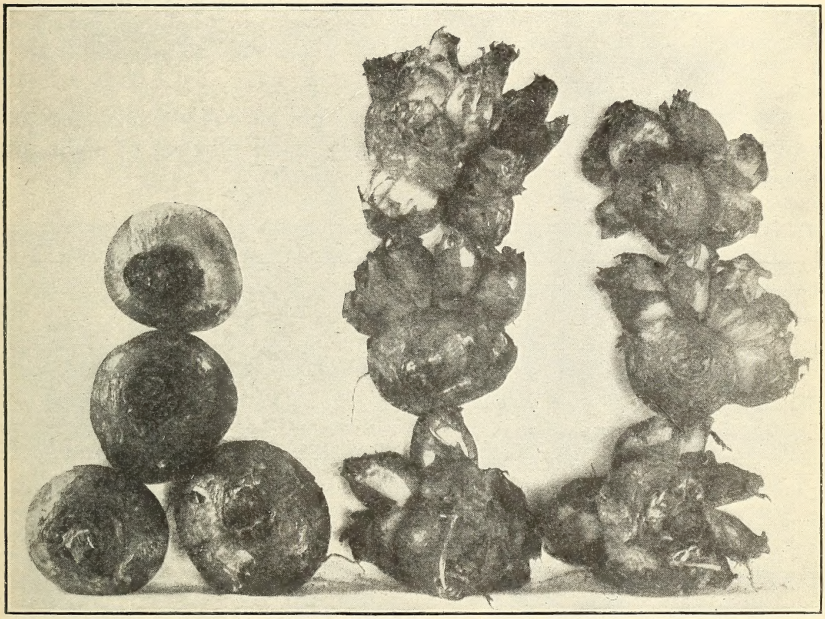

FIG. 2.—Hyacinth bulbs, showing, on the right, slabs naturally produced by six bulbs of the Roi des Belges variety and, on the left, for comparison, four bulbs without slabs.

SLABS.

Slabs are produced to some extent by bulbs under ordinary cultivation. Their greatest production, however, is from overmature bulbs. Figure 2 shows a few such bulbs that were harvested at the United States Bulb Garden in the season of 1912. Slabs similar to those produced by the six bulbs shown on the right in this illustration are naturally produced by 75 per cent of overmature bulbs.

[1] Library of Universal Knowledge, v. 8, p. 103; The Fruit, Flower, and Kitchen Garden, p. 273.

The time required to produce mature bulbs by this method is from two or four years, depending, of course, upon the variety, the size of the slabs, and the conditions under which they are grown. This

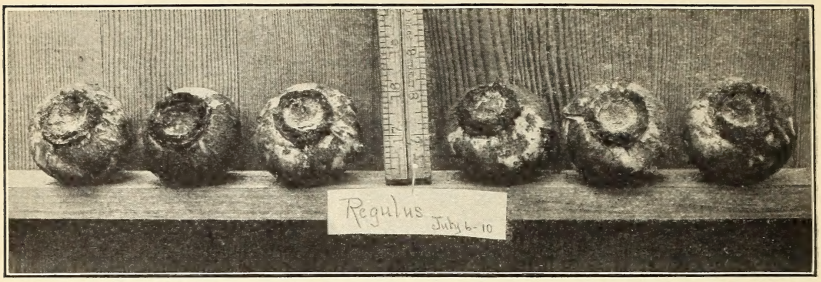

FIG. 3.—Six equally good mother hyacinth bulbs of the Regulus variety ready for scoring or scooping. Figure 4 shows bulbs of the same variety one month after being scored and scooped.

method is not employed to any great extent in commercial hyacinth growing on account of the comparatively small number of slabs produced.

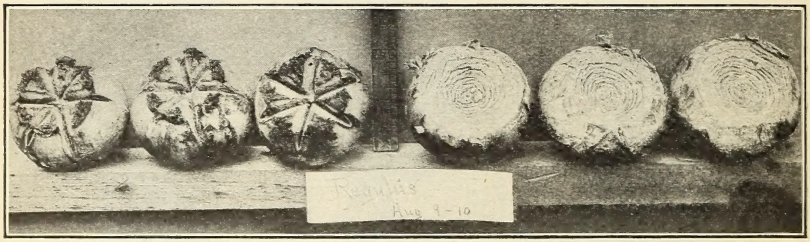

FIG. 4.—Mother hyacinth bulbs scored and scooped. The work in the Netherlands, and until last year in this country, has always been done by hand, an ordinary straight-bladed knife being used in scoring and sometimes in scooping. As a rule, however, the knife with a curved blade shown in figure 5 is used in scooping mother bulbs. Bulbs on left, scored; those on right, scooped.

SEED.

Owing to the wide variation in the bulbs grown, the method of growing bulbs from seed is rarely, if ever, employed except for the

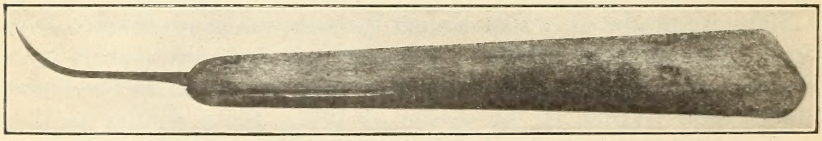

FIG. 5.—Knife used in the Netherlands for scooping bulbs.

production of new varieties. The time required to produce mature bulbs from seed is longer than by any of the other methods. Normally from five to eight years are required, depending upon the

variety producing the seed and the conditions under which the plants are grown.

SCOOPING.

The method of propagating hyacinths known as "scooping" is the one most extensively employed in commercial work, for the

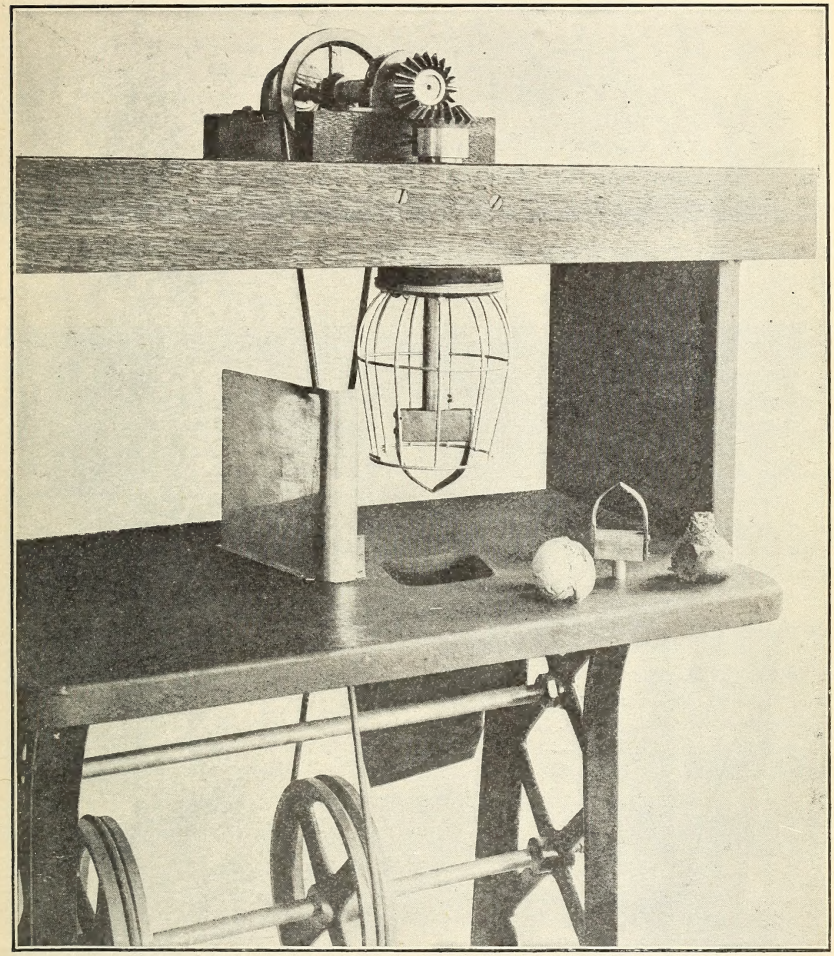

FIG. 6.—Upper part of a machine used to scoop mother hyacinth bulbs. To the right of the knife on the table are a scooped and an unscooped bulb and an extra scooping knife. The machine is extremely simple, easy of operation, and will effect a saving of 25 per cent or more in time as compared with scooping by hand.

reason that by it the largest number of bulblets are produced. The number and vigor of the bulblets are proportionate to the size and strength of the mother bulb, and consequently the strongest and best of the mature bulbs are selected for scooping.

By this method the base of the mature or so-called mother bulb is scooped out so as to expose the lower part of the scales just a little

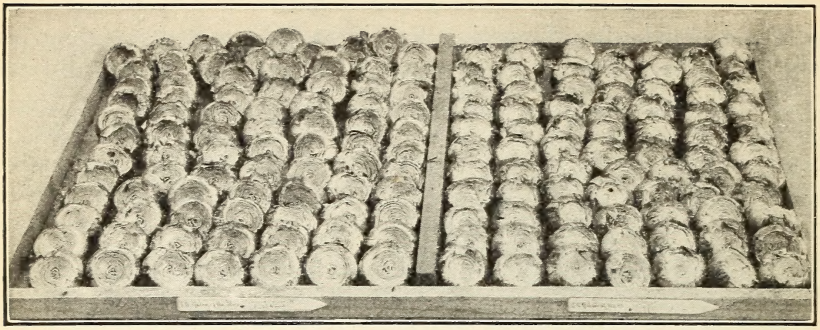

FIG. 7.—An average sample of hand-scooped and machine-scooped mother bulbs. Hand-scooped bulbs on the left; machine-scooped bulbs on the right.

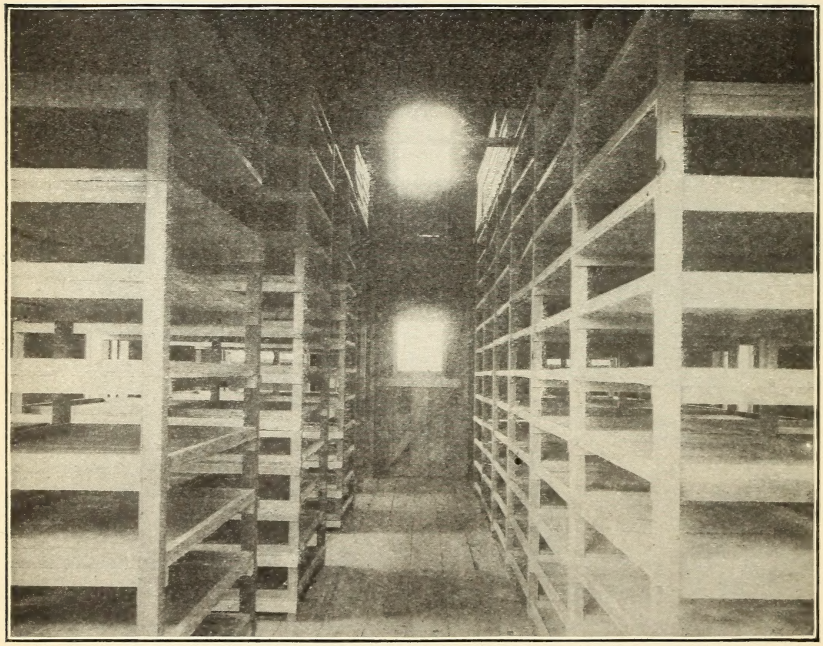

FIG. 8.—Interior of the frame propagating house built at the United States Bulb Garden in the spring of 1912. The movable trays are in place ready to receive the bulbs. The house is equipped with a hot-water heating apparatus, so that any desired temperature can be maintained during the time the mother bulbs remain there, which is from three to four months. The temperature maintained is from 75° to 90° F. day and night.

above where they unite with the base of the bulb. (Figs. 3 to 6, inclusive.) Cutting the bulb in this way destroys the growing point and flower bud, and all the latent strength of the bulb that otherwise

would have entered into the production of the plant and flowers is used up in the production of baby bulbs. After scooping, the mother bulbs are put in trays and placed in the sun for about a day for the purpose of drying the freshly cut surfaces. (Fig. 7.) The trays are then placed in a propagating house where ventilation and light can be controlled (fig. 8), where a temperature of from 75° to 90° F. is maintained. Sometimes sand, ashes, or air-slaked lime are dusted over the freshly cut surface to assist in absorbing the moisture caused by scooping out the base of the bulbs before they are placed in the propagating house. The scales soon separate somewhat, callus, and produce young bulblets. If the mother bulbs are scooped soon after harvest (say at some time in July) and properly handled, they should produce a fine lot of baby bulbs by planting time in October. (Fig. 9.)

FIG. 9.—Mother hyacinth bulbs that have developed an excellent crop of young bulblets. If properly handled, the mother bulbs at the time of planting should resemble the two bulbs shown above.

The time required to mature bulbs by this method is from four to seven years, depending more or less upon the variety, the size of the bulblets, and the conditions under which they are grown.

SCORING.

Scoring is the second most important commercial method of propagating hyacinths. By it fewer but larger and stronger bulblets are produced. On this account the smaller and poorer mature bulbs are generally selected for scoring. The process consists in making from two to four cuts across the base of the bulb, depending upon its size, and extending through to about its center. The fewer the cuts, as a rule, the fewer and larger the bulblets. (See fig. 4.) The process of scoring kills the flower and growing point, and the strength of the bulb that would have been used in producing a plant and flowers is utilized in the production of baby bulbs, the same as in scooping.

The scored mother bulbs are treated and handled in practically the same way as those that are scooped. Some growers prefer to place the scored mother bulbs out of doors and cover them with about 6 inches of soil, where they are left for about six weeks. They are then uncovered, and after drying for about a day are brought into the propagating house and given practically the same treatment as the scooped mother bulbs.

The time required to mature bulbs by this method is from three to five years, depending upon the variety, the size and strength of the bulblets, and the conditions under which they are grown. During the period when the young bulblets are being produced as a result of scooping and scoring, the greatest care must be taken to protect them from injury from dampness, cold, heat, disease, etc.

FIG. 10.—One of the first beds of scooped mother bulbs of the hyacinth planted at the United States Bulb Garden. Photographed in October, 1909.

STOCK MOTHER BULBS.

The stock of mother hyacinth bulbs for use at the Bellingham garden is imported annually and will have to be until the home-grown stock from the first propagation made at the garden in 1909 reaches maturity; this under normal conditions will be from one to three years hence. It has not been possible to have the imported bulbs delivered at the Bellingham garden until some time in October, which is entirely too late for scooping and scoring that season. This necessitates growing them one season. They are therefore planted, as soon as possible after being received, in beds 36 inches wide and of any desired length. The soil is spaded out of the first bed, and the bulbs are placed about 4 to 6 inches apart in rows 6 to 8 inches apart across the bed and covered to a depth of 3 or 4 inches with soil from the adjacent bed. This process is continued until the bulbs are all planted.

The beds are then covered with 3 or 4 inches of litter (straw or grass) for protection during the winter. In the spring this litter is usually raked off; sometimes it is left as a mulch. During the growing season the plants are kept free from weeds. The beds are frequently inspected for sickly or diseased bulbs. If any are observed, they, with about 6 inches of the surrounding soil, are removed and burned. In the spring the truss of the flowers is pinched out just about the time they are coming into full bloom. By this treatment the strength of the plant that normally is used in the development of the seed is forced into the development of the bulb. The stronger and larger the bulbs, other things being equal, the better the results from scooping and scoring. The bulbs are mature about June, and are then lifted and, when properly dried in the field, placed on shelves in a well-ventilated bulb house to cure.

This process requires from four to six weeks, depending somewhat upon the condition of the bulbs, the weather conditions, and the attention given to the details of the work. When properly cured the old roots and dry scales are rubbed off and the bulbs graded into firsts and seconds for scooping and scoring.

In the spring of 1912 officials of the Bureau of Plant Industry perfected a power machine for scooping mother bulbs. (See fig. 6.)

In order to test the effect of machine-scooped compared with hand-scooped hyacinth bulbs, one half of the mother bulbs intended for scooping in 1912 were hand-worked and the other half machine-worked.

A careful inspection shows that the hand-scooped bulbs are somewhat smoother and cleaner cut and the scales more widely separated from each other than is the case with the machine-scooped bulbs. It remains to be seen, however, whether the yield of bulblets is influenced by these conditions or whether a larger amount of disease develops in the machine-scooped bulbs, owing to the fact that possibly disease can not be so readily detected in the mother bulbs when using the machine as when the work is done by hand. The use of machinery for this work is interesting, and if the results are satisfactory will mean the saving of considerable time where large quantities of bulbs are to be scooped. On account of the comparatively small number of bulbs that would be scooped, however, even when bulbs are extensively propagated, the time saved in scooping would not compare with that which might be saved by the use of machinery in harvesting, cleaning, grading, etc.

The scooped and scored mother bulbs, when in proper condition, are placed in trays or on shelves in the propagating house. (See Fig. 8.)

PLANTING MOTHER BULBS.

In planting, care must be taken not to break off the baby bulblets. The scooped and scored mother bulbs with bulblets attached are planted in the field in beds about 36 inches wide and of any desired length, probably in the majority of instances with their bases up. Excellent results have been obtained at the United States Bulb Garden by planting them base down. In fact, the limited experiments and observations there lead to the belief that the best results will follow this practice. Additional observations and experiments will be required, however, before this practice of planting the mother bulbs can be unqualifiedly recommended.

The bulbs should be placed about 4 inches apart in rows 6 to 8 inches apart across the beds and covered with from 3 to 4 inches of soil. The bulbs in one end of the bed shown in figure 10 have been covered with soil. Later, when all the bulbs have been covered, the soil will be raked smooth and the bed mulched with 3 or 4 inches of litter (straw or grass) for winter protection. At harvest time the

FIG. 11.—Colonies of bulblets of hyacinths of the Gertrude variety from scored mother bulbs (on the left) and from scooped mother bulbs (on the right), both harvested in July, 1911.

mother bulbs will have practically disappeared and clustered close together where each mother bulb was will be found a colony of baby bulbs. The bulblets of each colony vary greatly in size and number. The difference in the size and number of the bulblets secured by means of the two methods is plainly noticeable. (Fig. 11.)

When harvested in June or early July the bulblets are placed 1 or 2 inches thick on shelves or in trays in the bulb house to cure. When they are sufficiently dried out, which requires four to six weeks, the dry roots, dirt, and remains of the mother bulbs are removed and the bulblets sorted. The largest and strongest ones make up the first grade and the smaller ones the second grade. As previously stated, larger but very many less bulblets are secured by means of scoring than by scooping.

Table II shows the comparative results obtained from the scooping and scoring methods of propagating hyacinths employed at the United States Bulb Garden.

TABLE II.—*Results of scooping and of scoring hyacinths at the United States Bulb Garden at Bellingham.*

Method of propagation.	Number of mother bulbs.	Progeny.					
		First size.		Second size.		Total.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Scooped bulbs	2,441	900	37	54,840	2,247	55,740	2,284
Scored bulbs	2,101	2,995	142	16,383	780	19,380	922
Total	4,542	3,895	86	71,223	1,569	75,120	1,654

FIG. 12.—Men at work planting baby hyacinths at the United States Bulb Garden in the fall of 1912. Under normal conditions and with proper culture and care, bulblets planted in this way in the fall should make a strong, vigorous growth.

PLANTING BULBLETS.

The baby bulbs are planted in September or October in beds about 36 inches wide and of any desired length. The best of the baby bulbs are placed about 2 inches apart in rows 4 to 6 inches apart and covered with soil to a depth of 3 to 4 inches. The second-grade bulbs the first year are scattered thinly in rows across the beds 4 to 6 inches apart. (Fig. 12.)

NARCISSUSES.

In continental Europe and Great Britain the narcissus is possibly more highly prized than in America. Narcissus enthusiasts there

have paid from $500 to $2,000 for the stock of a variety of narcissus of exceptional merit, possibly not so much on account of the intrinsic value of the variety as because of the rivalry of enthusiasts in securing and controlling the entire stock of meritorious varieties.

It is an established fact that the narcissus in variety can be successfully grown commercially in various sections of the United States. At Portsmouth and Richmond, Va., Santa Cruz and Ukiah, Cal., and in other sections the growing of the narcissus, either for cut flowers, bulbs, or for both, has developed into an industry of considerable commercial importance.

The slabs and young bulbs that are being grown to maturity and the matured bulbs grown for cut-flower production are planted in

FIG. 13.—Flowers of the Double Van Sion narcissus. The flower on the right is an average normal well-developed one from an imported bulb grown at Washington, D. C., for one season (fall until spring); the one on the left is a typical specimen of an abnormal, greenish flower from a home-grown bulb that had been grown at Washington, D. C., more than one season and is absolutely worthless.

the fall, 4 to 6 inches apart in narrow beds and covered with from 3 to 5 inches of soil. The flowers are harvested and sent to market in early spring. The bulbs are left in the beds undisturbed for two or three years; then, when the foliage matures and turns yellow, which under normal conditions is in June and July, the bulbs are lifted, cured, and graded, the largest ones sold, and the others replanted in the fall and treated as before.

Narcissuses have become acclimated in practically all of the old gardens in the United States and each spring add beauty and charm to the landscape.

The experiments at the Bellingham garden have demonstrated beyond question that narcissuses of excellent quality can be grown there and that the Double Van Sion variety, one of the most popular of the forcing narcissuses and one that heretofore has baffled every effort to produce it commercially in this country, can be successfully grown in the Puget Sound region. The first flowers from imported bulbs of this variety are usually fine, perfect, double flowers of excellent substance and quality. (Fig. 13.) The same bulbs if grown longer than the first season after being imported produce as a rule throughout the United States, with the apparent exception of the Puget Sound region, greenish, malformed flowers. The trumpet

FIG. 14.—Flowers of the Double Van Sion narcissus, showing a striking improvement and return to the normal flower. *A*.—An average malformed flower the first season after planting at the United States Bulb Garden, produced from a bulb grown in the bulb-growing districts of the East for more than one season after being imported. *B*.—An average flower the second season after planting, from a bulb from the same source. *C*.—An average flower the third season after planting, from a bulb from the same source. Photographed April 19, 1911.

splits or breaks into perianthlike segments and very frequently takes on a greenish yellow or green color, i. e., the flowers are said to "go green." The perianth also often becomes greenish or greenish yellow. Such flowers are absolutely worthless.

For the purpose of determining what effect the climatic and soil conditions of the Puget Sound region would exert upon bulbs of the Double Van Sion narcissus that have been grown in other parts of the United States for several years, a number of the bulbs were

secured from a grower in one of the Eastern States and tested at Bellingham. Figure 14 graphically shows the results of the test.

The flowers from bulbs grown at the garden for three seasons were practically perfect and compared favorably with those from imported bulbs. Mr. John W. Macrae Smith and possibly others secured similar results with this variety in their early experiments in bulb growing near Bellingham.

FIG. 15.—American-grown and Holland-grown tulips in alternate rows on the trial grounds of the United States Department of Agriculture. Beginning on the left, rows 1, Keizerskroon, 3, Pottebakker White, and 5, Proserpine, are from imported bulbs. Rows 2, Keizerskroon, 4, Pottebakker White, 6, Proserpine, are from Bellingham-grown bulbs. The bulbs from both sources were ordinary commercial stock. Photographed April 20, 1911.

PROPAGATION.

The narcissus is propagated by seeds when it is desired to secure new varieties. The commercial method of propagation of the narcissus, however, is by offsets. The increase secured at the garden varies, according to the variety, from 99 to 380 per cent, and the time required to grow commercial bulbs from slabs is from three to five years, depending upon the variety, the size and vigor of the offsets, and the conditions under which they are grown.

TULIPS.

It is stated [1] that tulips were introduced from Turkey by Busbecq to Vienna, and thence, about the year 1560, to the Netherlands, where their beauty and variety of coloring soon created much emulation and their popularity culminated in the historic craze known as the "Tulipomania." It is reported that at that time from 2,000 to 5,000 florins, equivalent to $804 to $2,010 of American money, were paid for a single bulb of a new, especially meritorious variety.

Tulips in variety can be successfully grown in commercial quantities in many sections of the United States. The tests so far show

FIG. 16.—Digging tulips at the United States Bulb Garden. The five young men or boys shown in the illustration will each dig on an average one bed, 3 by 75 feet, a day. Photographed July 10, 1912.

that tulips grown at the United States Bulb Garden are superior in several respects to imported bulbs. (See fig. 15.)

PROPAGATION.

The propagation of the varieties of tulips tested at the garden has been by offsets. The increase is from 67 to 273 per cent, depending upon the variety. The bulbs for the most part have been planted in beds, practically the same as hyacinths. If new varieties are desired, they are secured by means of seed.

HARVESTING.

The methods of harvesting tulips are essentially the same as those employed in all bulb-growing regions. The bulbs are dug out by hand with a small, short-handled spade when the soil is at all heavy, or with the fingers when the physical condition of the soil will permit. (Fig. 16.)

[1] The Gardener's Assistant, v. 1, p. 517.

FURROWING OUT BEDS BY MACHINERY.

Machinery in connection with the bulb work is being substituted for hand labor whenever possible. To this end for the past two seasons a limited number of tulip bulbs have been planted in long, narrow beds about 18 inches wide in order to test machinery in digging the bulbs. Figures 17 and 18 show the manner of making and planting these beds at the United States Bulb Garden. An ordinary turning plow has been used in that section for opening beds for bulbs, but, so far as the writer is aware, this is the first time a celery ridger has been used for this purpose.

FIG. 17.—Opening furrow beds with a celery ridger.

FIG. 18.—Planting tulips in furrow beds.

The bottom of the broad furrow that is opened with the celery ridger, drawn by a horse, is raked smooth by hand and the bulbs planted in the ordinary way from 4 to 6 inches apart in rows. (See fig. 18.) With this method of planting it will be possible to test machinery in harvesting.

OUTSIDE TESTS.

Flowering tests on the trial grounds of the United States Department of Agriculture in the season of 1910 and 1911, embracing a number of varieties of Bellingham-grown and Holland-grown tulips, showed remarkable superiority of the home-grown product over the

imported. Fifty bulbs of the same variety, from imported and Bellingham stock, respectively, were planted in rows side by side on the same date and continued under the same conditions throughout the experiment. As a rule, the plants from the Bellingham bulbs were freer from disease and flowered from five to seven days earlier than those from imported bulbs. In addition to this, the flowers were on longer stems and were of better color and quality than those from the imported bulbs. Figure 15 shows three of the varieties that were included in this test.

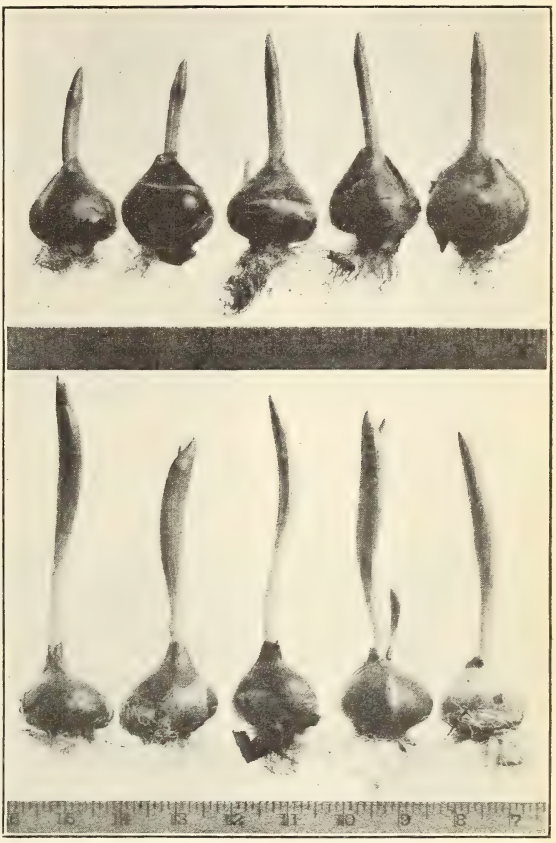

FIG. 19.—Bulbs of imported and Bellingham-grown tulips. Five bulbs of the Couleur Cardinal variety that were taken from the end row of one of the two flats of imported stock (upper figure) and five bulbs of the same variety taken from the end row of one of the two flats of Bellingham-grown stock (lower figure). The two lots of bulbs were planted in the boxes on October 30, 1912, all being treated alike, and taken into the greenhouse on January 25, 1913. The bulbs in both cases were removed from the flats on the following day and photographed on the same plate, side by side.

FORCING TESTS.

Figures 19 to 21, inclusive, show some of the results of a forcing test of Bellingham-grown and imported tulip bulbs during the season of 1912–13 at a greenhouse of the United States Department of Agriculture, Washington, D. C., and at a commercial greenhouse in the same city.

The differences between the Bellingham-grown and imported bulbs of several other varieties included in this season's forcing test are equally as striking as those shown in figure 21.

In the case of the Keizerskroon variety, the difference in the size of the plants and the time of flowering is not quite so marked as in other varieties. There is, however, a noticeable difference in favor of the Bellingham-grown bulbs both in the height of the plants and

the date of flowering. Flowers from Bellingham-grown bulbs were cut on February 16 and from imported bulbs on February 21 and 22, 1913. The results of the forcing tests of the season of 1912–13 verify those secured out of doors in 1910 and 1911.

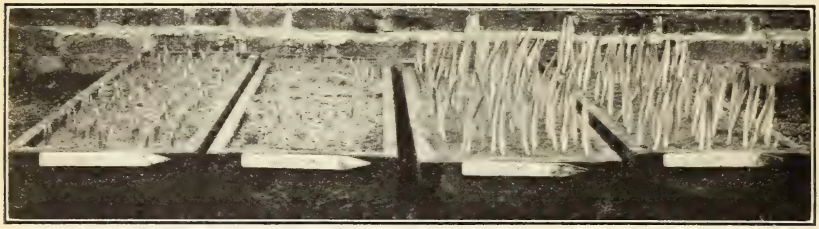

FIG. 20.—Flats of imported and Bellingham-grown tulips. The two flats on the left contain imported bulbs; the two on the right, bulbs grown at the United States Bulb Garden. Both lots are of the Couleur Cardinal variety planted October 30, 1912, and both received the same treatment. They were brought into the greenhouses of the Department of Agriculture and photographed on January 25, 1913.

The bulbs used in these tests were not selected, but were the ordinary run of what is considered commercial stock. That these tests do not absolutely establish the superiority of Bellingham-grown tulips over imported stock is realized, and other tests will have to be made in order to determine beyond question whether or not

FIG. 21.—Imported and Bellingham-grown tulips in flower. This illustration shows the condition of the plants from imported and Bellingham-grown bulbs of the Couleur Cardinal variety just 32 days after they were taken into the greenhouse of the United States Department of Agriculture. The plants from imported bulbs in the two flats on the left range from 3 to 9 inches to the top of the flowers. The few flowers that are in bloom are too short stemmed to be of any commercial value. The plants from the Bellingham-grown bulbs in the flats on the right range from 8 to 11 inches to the top of the flowers. Practically all of the latter plants are in full bloom, and 90 per cent of them are of commercial value.

American-grown tulips and narcissuses when forced or growing out of doors will produce better and healthier plants and yield earlier and larger flowers on longer and stronger stems than the same varieties grown in the Netherlands.

SUMMARY.

The tests of the United States Department of Agriculture of the possibility of growing so-called "Dutch bulbs" in this country have shown very encouraging results and are attracting widespread interest.

Thousands of people from Bellingham, Everett, Tacoma, Seattle, Portland, and other cities visit the garden near Bellingham, Wash., each spring to enjoy the hundreds of thousands of blooms with their many gorgeous colors, which are in masses such as can not be seen elsewhere in this country, making a most magnificent sight.

Interest in the possible outcome of this work is not confined to the people of the United States, for already representatives of several bulb farmers in the Netherlands have visited the garden, inspected the work, and observed the results.

Before the Department of Agriculture will be justified in advocating the growing of so-called "Dutch bulbs" as a commercial industry in this country much remains to be learned regarding the climatic and soil conditions best suited to the crop; the selection, clearing, grading, and preparation of the land (much of that in the far Northwest which is now thought to be well located and suitable to bulb growing will cost from $75 to $150 per acre to put it in shape for planting, in addition to the cost of the land); the prevention and control of diseases affecting the crop, of which a considerable number are more or less serious; and the propagation, cultivation, fertilization, growing, harvesting, curing, storing, transportation, and marketing of the crop.

The Department of Agriculture extends a hearty invitation to all who are interested in this enterprise to visit the bulb garden and inspect the work.

The representative of the Department in charge of the garden will welcome visitors and be glad to give information relative to the work that is in progress.

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